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Late Cenozoic Lava Dams in the Western Grand Canyon

ABSTRACT

The late Cenozoic basalts in the western Grand Canyon constitute one of the most unique and spectacular displays of volcanic activity in North America. Numerous flows were extruded on the Uinkaret Plateau and cascaded over the outer rim of the Grand Canyon into Toroweap Valley and Whitmore Wash, more than 600 m below. Others were extruded within the Grand Canyon itself and partly covered the Esplanade Platform. Some flows cascaded over the rim of the inner gorge and formed spectacular frozen lava falls 900 m high. The lava flows that entered the inner gorge formed a sequence of lava dams impounding the water of the Colorado River to form a series of temporary lakes upstream. The lakes soon filled with water and sediment and, as they overflowed, new gorges were eroded through the lava barriers leaving only small remnants of basalt clinging to the steep canyon walls. In all, during late Cenozoic time, more than 150 lava flows have poured into the western Grand Canyon and formed a sequence of 13 major dams ranging from 60 m to more than 600 m high. The larger lakes impounded upstream were more than 600 m deep, with the shoreline located near the base of the Redwall Limestone in the area of the Park Headquarters. Two of the larger lakes extended far upstream into Utah, beyond the present shoreline of Lake Powell.

Both the formation and destruction of the lava dams occurred in a remarkably short period of time. The small, single-flow dams were formed in a matter of days. Larger complex dams, involving multiple flow events, required several thousand years to form, and included several cycles of partial erosion between periods of extrusions. The lakes behind the dams would form in a matter of years and would be completely full of sediment in several hundred years. Destruction of the dams was also rapid. The overflow of the Colorado River at the downstream end of the dam undoubtedly formed rapids and waterfalls that quickly migrated upstream. As the falls approached the crest of the dam they may have become almost as high as the dam itself. The larger dams could have formed waterfalls nearly 600 m high. Judging from rates of waterfall migration in the Niagara River, most of the dams could have been destroyed by waterfall migration alone in less than 20,000 yr.

Although numerous volcanic extrusions have occurred within the Grand Canyon during the last 2 m.y., most of the lava dams are less than 1.2 m.y. old. The rapid rate with which the dams were built and then destroyed indicates that the 13 major dams existed in the Grand Canyon for a total of only 250,000 yr. Although short-lived, the lava dams were undoubtedly the most significant event in the late Cenozoic history of the Grand Canyon.